North Coast Watershed Assessment Program

DRAFT

Mattole Watershed Synthesis Report

The mission of the North Coast Watershed Assessment Program is to conserve and improve California's north coast anadromous salmonid populations by conducting, in cooperation with public and private landowners, systematic multi-scale assessments of watershed conditions to determine factors affecting salmonid production and recommend measures for watershed improvements.

Public Review Draft

Mattole Watershed Profile

Introduction

Mattole means “clear waters” in the language of the Athapaskan-speaking Mattole and Sinkyone peoples who occupied the Mattole valley when the first European settlers arrived in the early 1850’s. Little is known about them, for they were subject to extirpation and re-location at the hands of the settlers within ten years of contact. Based upon the practices of other North Coast native peoples, it is presumed they utilized an abundant and local salmon and steelhead resource for their sustenance.

We have little specific information about the levels of abundance of those mid-nineteenth century fishery stocks. However, based upon turn-of-the-century cannery records from the river systems in northwestern North America, including the neighboring Eel River, we can infer a great deal about the historic plenitude of chinook, coho, and steelhead in the Mattole. Old-timers and descendants of those early settlers, like Cecil Etter, born at the beginning of the twentieth century in a house that still stands near the confluence of Honeydew Creek and the Mattole River, reported an ever-ready supply of salmon and steelhead before the floods of 1955 and 1964. Those fish were easily caught for the table or smokehouse with a pitch fork or gaff hook in “any creek of the Mattole.” With a twinkle in his eye, he added, “before the war (WWII) no-one knew what a fishin’ pole was, or what one was good for in regards to salmon or steelhead.” (C. Etter, personal communication).

More recent accounts from Mattole anglers like Lynn Mantooth, “Hippie Bob,” and the “Nevada Boys,” fishing in the 1945 – 1970 period, describe a fabled sport fishery where in good stream conditions a group of four or five anglers could expect to hook and release over a hundred fish, mostly steelhead, in a day of fishing (J. Clary, personal communication). Salmon poaching beneath the Petrolia Bridge, and elsewhere, was a viable means of making a “little Christmas money” by selling fresh and smoked salmon as late as the 1960’s, (C. Wright, personal communication).

By the late 1970’s, those fish populations had collapsed to levels that alerted locals to their depressed condition, and initiated the formation of the Mattole Salmon Group. In 1981, the Mattole Salmon Group with the cooperation of landowners, and the support of the California Department of Fish and Game (DFG), and others like the Mattole Restoration Council, began stock restoration activities that included public education, artificial propagation and habitat improvements. Their efforts have been important in preserving the Mattole’s fragile fishery stocks in the face of very challenging conditions.

Today, those ancient and robust Mattole salmon and steelhead stocks, like most on California’s North Coast, are depressed to levels that have led to listing of coho, chinook, and steelhead under the authority of the Endangered Species Act. Additionally, we have enough current water quality observations to believe that the residents of the Mattole in 2001 would likely not have thought to name their valley’s river “clear water.”

Location and Area

The Mattole River basin encompasses approximately 296 square mile of the Northern California Coast Range (see map on facing page). A small portion of the Mattole’s southern most headwaters originate in Mendocino County, but the vast majority of the basin is within Humboldt County. The Mainstem Mattole is approximately 62 miles long, and receives water from over 74 tributary streams. There are approximately 545 perennial stream miles in the basin. The Mattole River enters the Pacific Ocean approximately 10 miles south of Cape Mendocino (approximately 300 miles north of San Francisco). During most summers, a sand spit encroaches all the way across the river mouth to form a baymouth barrier, which creates a lagoon behind it. Generally the barrier remains until runoff from fall rains breeches it. However, in some years large swells at times of high tide overtop the barrier and a new outlet channel is carved through the barrier. This overtopping has occurred up to six times during a year before the lagoon finally remained closed.

The Mattole basin is mostly steep mountainous topography. The basin's higher elevation slopes commonly exceed 15 percent gradient. Broad, alluvial streamside flats are present in the lower valleys. The lower stream channels are dominated by large gravel bars typically composed of cobble, gravel and fine sediments, (Elements of Recovery, 1989). Headwater elevations range from 1350 feet at Four Corners at the mainstem headwaters, to 4087 feet at Kings Peak, which is located less than three miles from the ocean and is the tallest mountain in the coastal range.

Subbasin Scale

Natural variation among subbasins is at least partially a product of natural and human disturbances. Other variables that can distinguish areas, or subbasins, in larger basins include differences in elevation, geology, soil types, aspect orientation, climate, vegetation, fauna, human population, land use and other social-economic considerations. The combined complexity of large basins makes it difficult to speak about them concerning watershed assessment and recommendation issues in other than very general terms. In order to be more specific and useful to planners, managers, and landowners, it is useful to subdivide the larger basin units into smaller subbasin units whose size is determined by the commonality of many of the distinguishing traits.

For the purpose of this assessment, the Mattole Basin has been subdivided into five distinct subbasins. The subbasin and map tables (following pages) portray these subbasins and several of their attributes. Except for the estuary, the Mattole's Northern, Eastern, Southern, and Western Subbasins are each comprised of two or more of the California Department of Forestry and Fire Protection (CDF) Calwater 2.2a Planning Watersheds.

Population

There are three “post office” towns in the Mattole basin: Whitethorn in the headwaters region; Honeydew near the center of the basin; and Petrolia near the mouth. The total Mattole basin resident population in the year 2000 census was estimated at about 1,200 people.

Census data for year 2000 was analyzed to provide population estimates for each subbasin. The raw data was provided courtesy of the Mattole Restoration Council. The main Census Bureau statistical levels (in descending order) are: State, County, Census County Division (CCD), Census Tract, Block Group, and Block. The Mattole basin straddles the Ferndale CCD (northern portion) and the Garberville CCD (southern portion). Additionally, the basin is almost evenly divided between Census Tract 112 (Ferndale) and Census Tract 113 (Garberville). The chart on the following page shows population and density by square miles and stream miles.

Ninety percent of the Northern subbasin’s total population lives within three miles of the population centers of Petrolia or Honeydew, which are both near the southern boundary of this subbasin. The Eastern subbasin has the most “pockets” of population. This is due to the numerous rural subdivisions in this area. This trait is shared with the Southern subbasin. The major difference is that Southern subbasin populations are concentrated along the Mattole River and its’ major tributaries. Most of the Western subbasin population lives near the county roads running along the northern, eastern, and southern edges of this area. These roads lie near the river from the Estuary to Honeydew, near the downstream terminous of the Eastern subbasin, then generally follow the ridgetops until reaching the boundary of the Southern subbasin.

Insert Vikki's Population Chart here.

Mattole Basin Major Roads

Climate

The Mattole has a Mediterranean climate characterized by cool wet winters with high runoff, and dry warm summers with greatly reduced flows. Most precipitation falls as rain. Along the coast, average air temperatures range from 46 to 56 degrees F. Further inland, annual air temperatures are much more varied, ranging from below freezing in winter to over 100 degrees in summer. The Mattole basin receives one of the highest annual amounts of rainfall in California averaging 81 inches. Average rainfall near the coast in Petrolia is about 60 inches per year and well over 100 inches per year falls near the center of the basin in Honeydew. Extreme rain events do occur, e.g. over 240 inches fell over parts of the basin during 1982-83.

Hydrology

The Mattole River basin lies within the Cape Mendocino Hydrographic Unit, a subunit of the Eel River hydrographic Area as described by the Department of Water Resources in Bulletin Series 94-8. The Mattole River Hydrographic Unit Code: 18010107 as described by the United States Geologic Survey (USGS). The Department of Water Resources (DWR), Statewide Planning Program delineates the Mattole watershed within the North Coast Hydrologic Region (HR), the Coastal (#03) Planning Subarea (PSA), and the Mattole-Bear (#27) Detailed Analysis Unit (DAU).

Winter monthly stream flows in the Mattole River measured near Petrolia average between 1,710 and 4,170 cubic feet per second (cfs). However, peak flows measured on December 22, 1955 and December 22, 1964 were 90,400 and 78,500 respectively. Bank full discharge at Petrolia occurs at approximately 31,000 cfs. “Summer and fall flows drop below 60 cfs, with a minimum measured flow of 20 cfs” (Department of Water Resources).

High seasonal rainfall on bedrock and other geologic units with relatively low permeability and steep slopes contribute to the very flashy nature of the Mattole’s watersheds. In addition, the runoff rate has been increased by extensive road systems and other land uses. High seasonal rainfall combined with a rapid runoff rate on unstable soils delivers large amounts of sediments to the river. As a result, the Mattole River transports a large sediement load. This sediment is deposited throughout the lower gradient reaches of the system.

Diversions, Dams, and Power Generation

There are 50 licensed, permitted, or pending water rights within the Mattole River basin. This number does not include riparian users and other diversions that are not registered with the State Division of Water Rights (State Water Resources Control Board 2001). No major dams or power generating facilities are located within the Mattole River basin.

Geology

Bedrock underlying much of the basin has been tectonically broken and sheared making it relatively weak, easily weathered, and inherently susceptible to landsliding and erosion. The unstable bedrock and soil conditions combined with heavy rainfall, high regional uplift rates and seismicity produce widespread landsliding and large volumes of sediment input to streams. The geologic unit and/or landslide type present can affect the nearby sediment load (i.e., coarse versus fine-grained). The following provides a brief description of the basin geology and related landslide processes. Detailed discussions of the basin geology, associated mass wasting processes and land use issues are provided in the Geology Report (Appendices) along with 1:24,000 scale maps illustrating spatial distributions of the geologic units and mass wasting features. Table 4 summarizes the geologic attributes by subbasin.

Table 4: Geologic Attributes Summary in the Mattole Basin.

	Estuary	Northern	Eastern	Southern	Western
Predominant Geologic Unit(s)	Quaternary fluvial, beach, and dunes deposits	Franciscan Coastal Terrane; minor Yager terrane & Wildcat Group; Quaternary surficial deposits	Franciscan Central belt; Yager terrane; Coastal terrane	Franciscan Coastal terrane	Franciscan Coastal terrane; King Range terrane
Predominate Rock/Soil Conditions	Unconsolidated, migrating sand and gravel deposits	Weak, broken argillite and mélange; thick, clayey soils	Intact sandstone and argillite cut by broad shear zones with weak rock and clayey soils	Relatively strong, intact sandstone and argillite; thin, sandy soils	Relatively intact sandstone and argillite in King Range; more broken in eastern and northern areas
Typical Mass Wasting	Sediment transport/ deposition	Abundant earthflows; rock slides; composite slides; gully and stream bank erosion	Debris and rock slides in strong rock areas; earthflows, composite slides and gullies around shear zones	Debris slides; scattered deep-seated rock slides	Debris slides, deep-seated rock slides and debris flows
Relative Degree of Stream "Disturbance"	N/A	Highest in basin	High in specific portions of subbasin	Lowest in basin	Highly variable throughout subbasin

The Mattole basin is situated in a geologically complex and tectonically active area, with some of the highest rates of crustal deformation, surface uplift, and seismic activity in North America (Merritts, 1996). Basement rocks, assigned to the Coastal belt and Central belt of the Franciscan Complex by Irwin (1960) are predominantly structurally-deformed marine sedimentary rocks (McLaughlin and others, 1982, 1983, 1994) The Coastal belt has been divided into three pervasively folded, sheared and otherwise tectonically-disrupted terranes; from northeast to southwest, separated by generally northwest-trending shear zones, are the Yager, Coastal, and King Range terranes (McLaughlin and others, 1997). Late Cenozoic marine and non-marine deposits (Wildcat Group) underlie a limited area of the watershed west and northwest of Petrolia. Quaternary alluvial deposits cover the bedrock along streambeds in the lower reaches of some tributaries and mainstem Mattole River, while remnants of older surficial deposits are locally preserved on elevated fluvial terraces in some valley areas and on wave-cut terraces along the coast.

Where sandstone dominates and is relatively intact, sharp-crested ridges with steep slopes and well-incised drainages tend to develop, while clayey and sheared rock masses generally form rounded hilltops with gentle slopes and poorly developed sidehill drainages. These topographic subunits, mapped by McLaughlin and others (2000) show a rough correlation with the differing types of mass wasting. Deep-seated rotational slides and earthflows are common in mélange matrix of the Central belt. Debris slides are common on the steep slopes of the Yager terrain, where the strata are highly folded but generally less sheared and broken than adjacent units. Clayey argillite of the Coastal terrain mélange matrix underlies the expansive grassland and lightly wooded areas present in the northern portion of the basin where large earthflows and gully erosion are common. The sandstone and argillite of the Coastal terrain is generally more competent in the southeasterly portion of the basin where landslides are less common and predominantly occur in the form of debris slides. Along the easterly side of the King Range within the Mattole basin, mass wasting by debris sliding is common, with the associated development of inner gorge and debris slide slope geomorphic features. Large rockslide complexes are common in the King Range terrane along the coastal bluffs and steep coastal drainage basins.

Sediment supplied to streams can vary, dependant on the bedrock and/or landslide types being eroded. For example, debris slides in the King Range terrain are likely to produce coarser grained materials (sands and cobbles), while earthflows in mélange matrix of the Coastal terrane will produce significant amounts of finer grained materials (silts and clays) to erosive water flows.

Faulting, Seismicity, and Regional Uplift

The Mattole basin region is located in a complex tectonic setting near the junction of three crustal plates (North American, Pacific, and Gorda). The region experiences a high level of seismic activity, and major earthquakes have occurred in intraplate areas as well as along well-defined faults (Dengler et al., 1992). The major mapped fault zones in the Mattole basin include a possible extension of the San Andreas Fault and the Cooskie and Petrolia shear zones. The active San Andreas Fault cannot be traced north of Horse Mountain Creek, and it is possible that the primary structure lies offshore. The Cooskie shear zone is a poorly defined zone of sheared and broken rock which extends easterly from Punta Gorda, and the Petrolia shear zone is a similar structure which comes onshore near McNutt Gulch and extends southeast through Petrolia to just south of Honeydew along the Mattole River. The rapid uplift described below is being accommodated along a system of thrust faults, some of which may not extend upward to the ground surface. The Honeydew earthquake (1991, M 6.2) occurred on one of these faults, when the southwest block was thrust upward over the northeast block at depth.

High rates of regional uplift provide a regenerating source of sediment to the watershed. Wave-cut Holocene (<10,000 years old) platforms along the coast have been elevated up to more than 50 feet above a rising postglacial sea level (Merrits, 1996). Elevated alluvial and strath terraces along the Mattole River indicate that relatively high rates of uplift persist inland within the watershed. Following the 1992 Cape Mendocino earthquake sequence, extensive mortality of intertidal organisms from coastal emergence indicated a rough maximum of 1.4 m of coseismic uplift occurred between Cape Mendocino and the South side of Punta Gorda (Carver and others, 1994).

Vegetation

Prior to European settlement, coniferous forest extended throughout most of the 190,000 acre Mattole basin. Natural prairie grassland is concentrated on the northwestern portion of the basin, but prairie soils occur throughout the basin, mostly on ridgetops. The structural attributes, seral stages, and mix of species on the forestlands are determined by a combination of physical, biological, and disturbance factors. Physical factors include soil, moisture, temperature, and topography. The Mattole is unusual within the Northern California coast as having very little redwood forest present; it is thought to be primarily due to the King Range blocking the summer fog. The interaction between soil types and strong salt-laden air are also possible factors that influence the redwood free areas of much of the Mattole and Bear River basins (Zinke). Forested stands consist primarily of tan-oak and Douglas-fir as the major tree species. Madrone, big-leaf maple, chinquapin, bay, canyon live-oak and alder occur as minor components whose occurrence generally varies according to soil type, slope and aspect controlling summer moisture regimes. Seral stages are dependent upon disturbance regimes, both natural and human induced. Natural disturbance includes fire started by lightning. Other coniferous species include yew, isolated sugar pine stands and redwood in the southern headwaters.

Land Use

Athapaskan-speaking Mattole and Sinkyone peoples occupied the Mattole Valley at the time of first immigration of settlers in the early 1850s. Little is known about them, for they were quickly wiped out by settlers, culminating in the massacre at Squaw Creek (River Mile 12) in early 1864. Survivors were sent to the Round Valley Reservation in the Middle Fork of the Eel River, a hundred miles south, where they and their language became extinct. "In the span of eleven years, a culture and people which had been in place for hundreds or thousands of years was completely decimated." (Mattole Restoration Council 1989).

The first known explorer of the Mattole was John Hill of Fort Humboldt whose 1854 report glowingly described tall clover in the prairies, rich grassland in the valleys, and timbered slopes underlain by wild oats and other grasses (Humboldt Times Weekly, September 23, 1854). Within this report he noted the streams and their riparian corridors of alder, willow, and cottonwood and the Douglas-fir and tan-oak on the slopes. He mistakenly described redwood forests in the nearby woods (W.W. Roscoe, 1940). He also commented on the numerous Indians who appeared to have not seen white men before. This was the only first hand description of the land cited in Elliott's History of Humboldt County, 1881.

W.W. Roscoe provided a series of personal accounts in his self-published monograph, A History of the Mattole Valley, 1940. He recorded this interview of Samuel S. Pollock, one of the first Mattole Valley settlers, in which Mr. Pollock describes the vegetation and condition of the Grange area, about 9 miles upriver of Petrolia.

Pollock said, "The Mattole Valley was certainly a wonderful sight when I first saw it in the spring of 1857. There were no fences to stop a horseback rider then. I rode my horse all over the valley and right through the tall grass. My horse had hard work to get through the tall grass because it was so badly tangled up. My head would just stick above the grass heads as I sat in my saddle and guided my horse. Every little way a big buck deer or a buck elk, not to mention the little ones, would jump up and run away in the tall grass.

> "One day I say(sic) three big grizzly bears besides a number of black and brown bears. Gee whiz, weren't those grizzlies independent! They didn't try to hurt me. They just lumbered out of the way, then sat down and looked at me in a curious sort of way. I felt that it would be best not to go too close to them, so I turned my horse to one side and gave them wide berth. Jingoes, how different things look now. I wonder what the teacher and the children of the Upper Mattole School would think now if I could make them realize that their schoolyard and the country around looked like in June 1857, with the tall grass on the flat six or seven feet high, my horse out of sight as I rode, and that big grizzly bear looking at me from the ridge while the deer and the elk were running away. They can't understand it."

In 1858, just 4 years after Hill explored the valley, and with the influx of new pioneers, farming began in earnest. The very first settlers were farmers and ranchers who converted native grassland into homesites, home gardens, orchards and rangeland. As grazing activities increased, conversion of the adjoining forests began. Timber was harvested for local needs or simply felled and then areas broadcast burned for conversion.

Petrolia grew rapidly during the short-lived oil boom of 1864-65. Natural gas vents and oil seeping from the ground began a local land rush that almost doubled the Valley population of 282 to over 450 people by 1870(Elliott). While many land patents were obtained and numerous test wells drilled, there was never a truly commercial volume of oil produced. Many of the oil seekers remained.

Elliott's 1882 Encyclopedia of Humboldt County noted that the Mattole area produced butter, cheese, wool, beef, mutton and pork. The encyclopedia further states that though the best fruit of the county grows in the Bear River and Mattole districts, the distance to market was too great for commercial production. This theme of distance to market and poor roads is a recurring theme that has stymied rural prosperity in the Mattole (Roscoe, 1977).

Just after the turn of the century, tannin produced from the bark of tan oak trees became a commercial commodity in the Mattole basin. The Wagner Leather Company in Briceland processed tan-bark and shipped the solution in barrels to the wharf in Shelter Cove between the years 1901 and 1922 (Cook 1997). During the boom years, over three thousand cords of bark were processed each year by Wagner Company (Raphael, 1984). The Mattole Lumber Co. in the lower Mattole utilized a one mile rail line which led to a wharf constructed in 1908 at the mouth of the Mattole. The valley's tan oak groves were first hauled out by mule and then transferred to horse and wagon (Clark, 1981). The wharf required constant and expensive maintenance and was not rebuilt after a storm in the winter of 1913/1914. Tan bark harvesting continued until the supply was depleted in the early 1920's, (Clark, 1981) at about the same time that the tannin extract was replaced by synthetic products.

In 1941, the most widespread use of the watershed appears to have been grazing and is indicated by the amount of grassland and recent fires which appear to be deliberate conversion of pre-existing brush and timberland. Conifer timber harvesting activities are readily apparent near Harris Creek and continue further upstream into the redwood belt. Timber harvest operations began in earnest as Douglas-fir became a merchantable building material during the post World War II boom. The 1952 air photos show the beginning of the large scale timber harvesting era in the Douglas-fir forests of the Mattole basin. This was the first entry into most of the forest land by mechanized equipment. Harvests were not designed as silvicultural treatments and were an extractive land use. The on-the-ground effects varied from a type of selection to a seed tree cut with a large amount of remaining vegetation consisting of unmerchantable conifers, tan-oak, and brush. Many of these harvests became precursors to range conversion. The roading was typical of the time period; log landings and access roads were generally at the bottom of the slopes in or adjacent to stream channels.

By the late 1980s, timber harvesting decreased while environmental awareness increased. Changes in policy concerning management of federal lands and the designation of the Northern Spotted Owl as federally threatened led to the designation of BLM lands, a large proportion of the Western and a smaller percentage of the Eastern subbasins, as Late Successional Reserve (BLM, Bear Creek 1995) lands that are not subject to harvest. In the Eastern subbasin, Eel River sawmill proposed several harvest plans, some in old-growth, which were hotly contested. These lands became part of the effort by some groups, including those formed to influence BLM land use designations and policies on Gilham Butte, to create a "Redwoods to the Sea" wildlife corridor. In the Southern subbasin, increased harvest plans reflect the value of redwood timberlands and efforts to bring previously cut-over lands into greater productivity. The Northern subbasin contains the bulk of Pacific Lumber/Scopac ownership in the Mattole. Although Pacific Lumber is operating under an approved HCP, some of the timber harvesting plans are first entries into old-growth stands, causing protests that include civil disobedience.

In Table 5 the harvest periods are broken into irregular time intervals as a result of the way existing data was compiled. For the most part, the first period consists of the post-war logging boom although a portion of the southern headwaters were harvested just prior to the 1942 aerial photos. This category includes most of the area harvested and roaded before the 1964 flood which is estimated to be a one hundred year event, meaning that in any given year there is a one percent chance of the stream carrying the same volume of water. Thirty-eight percent of the basin was harvested during this time period. The harvest period 1964-1974, also prior to the establishment of the first iteration of the Forest Practice rules authorized by the Z'Berg-Nejedly Forest Practice Act of 1973, brought the cumulative total of 49% of the basin area logged by tractor and skidded downhill to log landings and access roads low on the slopes and often adjacent to streams. The next interval, 1974-1983, is a time period of Forest

Practice rules prior to substantive watercourse protection. The acres listed in the years 1984-2001 are based on the submission date of timber harvesting plans to the California Department of Forestry and Fire Protection. This time period is the most current and harvesting practices reflect increasingly restrictive measures for activities near watercourses. Only about 7% of the basin has been harvested since 1984. These years are broken into intervals that are similar to those used for other analyses in the NCWAP program.

Table 5: Timber Harvest History, Entire Mattole Basin.

TIMBER HARVEST HISTORY - ENTIRE MATTOLE BASIN		
	Total Acres	Percent of Area
Harvested 1945-1961	72,897	38%
Harvested 1962-1974	21,141	11
Harvested 1975-1983	6,948	4
Harvested 1984-1989	4,150	2
Harvested 1990-1999	7,866	4
Harvested 2000-2001 (partial)	583	<1

A rough rate of harvest would indicate that from 1945-1966, an average of 2.2 % of the basin was harvested per year, from 1962-74, one percent, and about one-half percent of the basin harvested per year from 1984-2001. Much of the basin is in young stands of trees. As these grow into harvestable size, one could reasonably anticipate an increased rate of harvest on private lands beginning in the next ten to twenty years.

Ranching has focused almost entirely on cattle since the passage of propositions limiting predator control options. Land holdings in the Mattole are increasingly fragmented and the amount of livestock is difficult to quantify. Many of the smaller ownerships have “hobby” lifestock, but there is no way to estimate numbers.

The 1960s were the beginning of the “back to land” movement of young, largely urban people onto subdivided property, generally recently logged. Many of these new residents were interested in learning how to work on their land, to rehabilitate it, and to find an income. Both Honeydew and Petrolia are about 2 hours driving time south of Eureka and provide few business opportunities for employment or shopping. There are some home-based businesses, but many people commute to the Highway 101 corridor in their own vehicles, as no public transportation exists (see map on facing page). Local unemployment was estimated at around 50% in 1999, but is acknowledged as variable because of seasonal work and an underground economy of marijuana cultivation. In 1999, over half of the elementary students were on a reduced lunch program but the enrollment of approximately 117 students does not include charter school students (www.co.humboldt.ca.us, 2001). There is a strong pride of place amongst many of the local residents that belies bleak and dismal statistics. Current census data indicates that there are at least 1132 people who call the Mattole Basin their home.

Table 6: Land Ownership of Mattole River Basin.

Ownership	Percent	Acres	Square Miles
Private Lands	83.6	158,509	247.7
Bureau of Land Management	15.8	30,022	46.9
Other Public Lands	0.6	1,230	1.9
Total		**189,761**	**296.5**

More recently, most of the land use in the Mattole Basin is centered on timber management, cattle and sheep ranching, pasture and field crops, and recreation in the King Range National Conservation Area (see map on facing page).

Many roads were built to gain residential and land use access throughout the basin. Roads have contributed untold tons of sediment to the river and its tributaries (Mattole Restoration Council, 1989). Table 6 presents land ownership in the Mattole River basin (California Rivers Assessment Interactive Web Database, 2001).

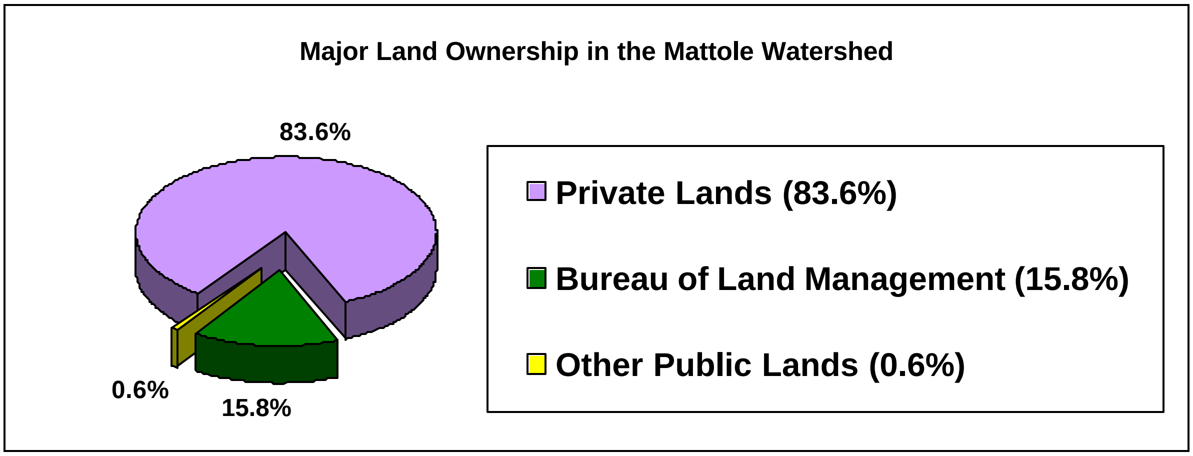

Figure 8: Major Land Ownership in the Mattole Basin.

Insert Basin Ownership Map here.

Fluvial Geomorphology

The nature and extent of erosional and depositional processes occurring within the Mattole Basin produce an array of fluvial geomorphologic features that can be correlated with stream channel types. These characteristics were assessed through aerial photograph review and limited field reconnaissance. Compiled map layers consist of alluvial contacts, stream features, gullies, and channel classification types. DMG's assessment chiefly focused on examining the stream features associated with sediment transport and source areas within the basin. Channel features, conditions, and historic changes were mapped to assess transport and response reaches. Source areas were evaluated using channel assessment features and hill-slope gullies as indicators. In addition, a reconnaissance evaluation of major stream types was conducted based on the Rosgen methodology which provides a general characterization of valley types and landforms, and identifies the corresponding stream types.

Mapped gravel bar networks are used in constructing the alluvial contacts layer for the geologic map. This layer includes mappable point, lateral, mid-channel and junction bars found in active stream channels. Vegetated bars and river terraces were also mapped.

Mapped channel assessment features are shown using the stream features layer, which incorporates features associated with sediment source and storage within or adjacent to the active channel. Those features include: lack of riparian vegetation, distribution and number of lateral or mid-channel bars, multi-thread channels, cut-off chutes, channel bank erosion, and shallow landslides adjacent to or blocking channels.

Mappable gullies, presented in the gullies layer, include those that appear active, have little to no vegetation within the incised area, are typically found in upslope areas and are of sufficient size to be identified on aerial photos. Most gullies are found in sparsely vegetated and/or grassland areas where the ground surface is observable. This creates a potential bias in the mapping of this feature, because gullies beneath canopy are not as visible. However, it is important to document these sediment source areas wherever they can be identified. Multiple year mapping helps define areas of ongoing surface erosion.

The channel classification overlay was used to categorize channel types based on the Rosgen methodology (Rosgen, 1996). Channels commonly identified included the A, B, C, G and F Rosgen types. In order to determine the appropriate stream classification, the general stream geomorphic characteristics for the Mattole River Basin were evaluated using a computer model of the topography and stream gradients. The channel classification layer uses quadrangle scale base maps that employ USGS topographic contours and stream drainage networks. The stream drainage networks were first color coded for gradient, and the stream channel network segments were then classified using gradient, stream sinuosity, and relative valley width.

Water Quality

Refer to NCRWQCB Appendix.

Aquatic/Riparian Condition

The riparian zone is the area between a stream or other body of water and the adjacent upland. It is identified by soil characteristics and distinctive vegetation. The riparian zone includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation. Riparian vegetation is the vegetation growing on or near the banks of a stream or other body of water on soils that exhibit some wetness characteristics during some portion of the growing season. The structure and composition of the riparian zone can be affected by the stream type and its active channel, as well as by geologic and topographic features. Functions of the riparian zone include: controlling the amount of light reaching the stream; providing litter and invertebrate fall; providing stream bank cohesion; buffering impacts from adjacent uplands; and providing large woody debris (Flosi et al. 1998). Riparian zones form a vital link between terrestrial and aquatic ecosystems.

Riparian zone functions are important to anadromous salmonids for numerous reasons. Riparian vegetation helps keep stream temperatures in the range that is fully supportive of salmonids by maintaining cool stream temperatures in the summer and insulating streams from heat loss in the winter. Larval and adult macroinvertebrates are important to the salmonid diet and they are in turn dependant upon nutrient contributions from the riparian zone. Additionally, stream bank cohesion and maintenance of undercut banks provided by riparian zones maintains prime salmonid habitat. Lastly, the large woody debris provided by riparian zones shapes channel morphology, helps a stream retain organic matter and provides essential cover for salmonids (Murphy and Meehan 1991). Therefore, disruptions to the riparian zone can have serious impacts to the aquatic community, including anadromous salmonids.

Fish Habitat Relationship

Anadromous Salmonid Natural History

Anadromous fish migrate to the ocean early in their life, mature in the ocean, and return inland as adults to spawn in freshwater streams and rivers. Chinook salmon, coho salmon, and steelhead are the predominant anadromous fish using the waterways of the Mattole River. Habitat requirements of salmon and steelhead in the freshwater environment vary to some degree for each species but are generally similar.

Chinook salmon. Mattole River chinook salmon are fall-run, migrating into the river as adults from October through February and spawning in the same period. Shortly after fry emerge from the gravel incubation nests, they begin to move downstream and arrive at the estuary throughout the Spring. In California, most chinook smolts enter the ocean during their first seven months of life. Chinook salmon generally mature at 3 to 4 years of age. Some precocious males mature at age 2 (commonly called “jacks”) and return to spawn and die along with the older, larger individuals from previous year classes.

Chinook salmon generally spawn in swift, relatively shallow riffles or along the edges of fast runs where there is an abundance of loose gravel. The females dig spawning nests (redds) in the gravel and deposit their eggs in the redd "pockets". Eggs are immediately fertilized by a male and covered with gravel by the female. The adults die within a few days after spawning. Water flows through the gravel and supplies oxygen to the developing embryos. An average female chinook salmon produces 3,000-6,000 eggs depending on the size of the fish.

Chinook salmon select spawning sites within narrow ranges of water velocity and depth. Spawning requires well oxygenated cool water. Velocity is generally regarded as a more important parameter than depth for determining the hydraulic suitability of a particular spawning site. The velocity determines the amount of water which will pass over the incubating eggs. Depths under 6 inches can be physically prohibitive for spawning activities. In general, optimum spawning velocity is 1.5 feet per second (fps), ranging from 1.0 to 3.5 fps. Salmon exhibit differences in preferred depths for spawning based on race and watershed. Mattole River fall-run chinook typically spawn at depths ranging from 1-5 feet.

Substrate composition is another critical factor in determining the suitability of spawning site selection. For successful reproduction, chinook salmon require clean and loose gravel that will remain stable during incubation and emergence. Average size of chinook salmon redds ranges from 75 to 100 square feet. In areas where spawning activity is high, redds of later spawners may be dug adjacent to, or super-imposed upon, earlier redds and some egg disturbance may occur. The territory required for pre-mating activity has been estimated to be between 200 and 650 square feet for a pair of salmon but this varies widely according to population density. Where spawning occurs throughout a protracted spawning season, as many as three or four redds may be dug in the area equivalent to the territorial requirement of one pair.

In general, the substrate chosen by chinook salmon for spawning is composed mostly of gravels from 0.5 to 5 inches in diameter with smaller percentages of coarser and finer materials with no more than about 5 percent fines. Although some spawning will occur in sub-optimal substrates, incubation success will be lower. Substrate composition must be low in sand and silt so that oxygenated water is allowed to freely permeate and flow through intra-gravel spaces, and to allow newly hatched salmon to move up through the gravel into the water column. Sediments deposited on redds can reduce water flow through the gravel and suffocation of eggs or newly hatched fry may occur. Gravel is completely unsatisfactory when it has been cemented with clays and other fines, or when sediments settle out and cover eggs during the spawning and incubation period.

The preferred temperature for chinook salmon spawning is generally 52EF with lower and upper threshold temperatures of 42EF and 56EF. Holding adults prefer water temperatures less than 60EF, although, acceptable temperatures for upstream migration range from 57EF to 67EF.

In the Mattole River system, chinook salmon eggs usually hatch in 40 to 60 days, and the young "sac fry" usually remain in the gravel for an additional 30 days until the yolk sac is nearly entirely absorbed. The rate of development is faster at higher water temperatures. Significant egg mortalities can occur at temperatures in excess of 57.5EF with total mortality normally occurring at 62EF.

After emergence, chinook salmon fry attempt to hold position in the water column and feed in low velocity slack water and back eddies. They move to somewhat higher velocity areas as they grow larger and make their way to the estuary. In the Mattole River system chinook salmon juveniles are detained in the estuary because of the creation of lagoon conditions early in the summer. This prevents them from going to the ocean until it reopens in Fall. Unfortunately, conditions in the estuary through the summer are not hospitable and studies conducted by Humboldt State University within the past fifteen years have shown high, and perhaps total, mortality in some years. Juveniles that enter the ocean and survive to adulthood, usually return to the system after their third or fourth year at sea.

Coho salmon. Coho salmon adults enter the Mattole River from October through December and reach the upper spawning reaches in November and January. In the shorter Califomia coastal streams, most return from mid-November through mid-January. Spawning commences shortly after arriving at the spawning sites provided that water conditions, including flow and temperature are satisfactory.

Redd construction behavior is similar to that displayed by other salmonid species, with the female excavating a depression in the gravel by turning on her side and using her body and tail to displace gravel downstream.

The number of eggs produced by the female is directly related to her size. Four-pound and ten-pound females produce about 2,000 and 2,700 eggs, respectively. Under optimum conditions, most eggs will be spawned.

The amount of time required for the incubation of coho eggs varies primarily with water temperature. Normally, four to eight weeks are required for incubation. Another two to seven weeks are required from hatching to emergence from the gravels (Shapovalov and Taft, 1954). Mortalities during this period can vary substantially. Under optimum conditions, mortalities can be as small as ten percent. However, under very adverse conditions such as scouring flows or heavy siltation, close to a complete loss may occur. Shapovalov and Taft (1954) estimated that under favorable conditions (in the absence of heavy silting) survival to emergence in Waddell Creek (Santa Cruz) was between 65 and 85 percent of the eggs deposited.

Juvenile coho will normally attempt to remain in the stream, in the vicinity where hatched, for one year. However, environmental factors, such as low summer flows or high water temperatures, or population pressures due to limited rearing space and food, will force the smaller, weaker individuals to relocate. Most of this movement is manifested in a downstream migration of fry during the first spring and summer.

Smoltification, which is the physiological change adapting young anadromous salmonids for survival in saltwater, normally occurs in California coho during the spring of the fish's second year. In recent downstream migrant studies on several Mendocino County streams and on Lagunitas Creek, juvenile coho emigrating from the streams ranged in size from 2.5 to 8 inches fork length indicating age 0+ and age 1, and averaged approximately 4.5 inches (Bratovich and Kelley, 1988; W. Jones, pers. comm.).

Coho typically spend two growing seasons in the ocean and return to spawn near the end of their third year of life. However, some males return to spawn near the end of their second year. Nearly all are precocious males (jacks) which, like their adult counterparts, die after spawning. Murphy (1952) estimated that the percentage of jacks returning to the South Fork Eel River above Benbow Dam from 1939-40 through 1950-51 ranged from 6.9% to 33.8%, with a mean of 18%.

Steelhead trout. Steelhead trout are an anadromous strain of rainbow trout that migrate to sea and later return to inland rivers as adults to spawn. In contrast to all Pacific salmon, not all steelhead die after spawning. In the Mattole River today, upstream migration occurs from November through May with the peak run occurring in January-February. Mattole River steelhead spawners are typically age four or five years and weigh 2 to 12 pounds or more. Female steelhead carry an average of 3,500 eggs, with a range of 1,500-4,500.

Like other salmonids, steelhead prefer to spawn in clean, loose gravel and swift, shallow water. Gravel from the redd excavation forms a mound or tail-spill on the downstream side of the pit. Eggs deposited along the downstream margin of the pit are buried in the gravel as excavation proceeds. An average of 550-1,300 eggs are deposited in each redd. The males fertilize the eggs as they are deposited. Water flowing through the gravel supplies oxygen to the developing embryos.

Water depth and velocity criteria for spawning and rearing steelhead differ slightly from those for salmon. Spawning velocity appears to be about the same as for chinook salmon, 1.5 fps, but depth is slightly less, to about 0.75 foot. Gravel particle sizes selected by steelhead vary from about 0.25-3.0 inches in diameter, somewhat smaller than those selected by chinook salmon.

Steelhead eggs seem less tolerant of fines than chinook salmon, probably because eggs are smaller and oxygen requirements for developing embryos are higher. A positive correlation has been demonstrated between steelhead egg and embryo survival and the rate of water flow through the gravel. Egg survival is highly dependent upon the flow of well oxygenated water. The average size of a steelhead redd is smaller than that of a chinook salmon. Redd sizes range from 22.5 to 121 square feet and average 56 square feet.

All freshwater life stages of steelhead, except rearing, require lower temperatures than chinook salmon. The preferred temperatures for steelhead are between 50EF and 58EF, although they will tolerate temperatures as low as 45EF. Studies show that the upper preferred temperature limit for rainbow trout in Sierra Nevada streams is 65EF. The temperature range for spawning is somewhat lower, ranging from 39-55EF, and the preferred incubation and hatching temperature is 50EF. During the egg's "tender" stage, which may last for the first half of the incubation period, a sudden change in water temperature may result in excessive mortality.

Egg incubation in the Mattole River system takes place from December through April. The rate of embryo development is a function of temperature with higher temperatures contributing to faster development. At 50EF, hatching occurs in 31 days; at 55EF hatching occurs in 24 days.

Newly hatched sac fry remain in the gravel until the yolk sac is completely absorbed, a period of 4-8 weeks. Emergence is followed by a period of active feeding and accelerated growth. The diet of newly emergent fry consists primarily of small insects and invertebrate drift. As they grow, fry move from the shallow, quiet margins of streams to deeper, faster water.

Unlike juvenile fall-run chinook salmon, which typically emigrate within 3 to 4 months after emerging from the gravel, juvenile steelhead usually remain in fresh water for two years. Because rearing steelhead are present in fresh water all year, adequate flow and temperatures are important to the population at all times.

Generally, throughout their range in California, steelhead that are most successful in surviving to adulthood spend at least two years in fresh water before migrating downstream. In the Mattole River, steelhead generally migrate downstream as 2-year old smolts during spring and early summer months. Emigration appears to be more closely associated with size than age, 6-8 inches being the size of most downstream migrants. Downstream migration in unregulated streams has been correlated with spring freshets.

Summer steelhead. (Adapted from Jones and Ekman, 1980.) Small populations of summer steelhead are found in less than a dozen streams in California. Summer steelhead enter the Mattole River between March and June. Fish remain in clear, cool, deep pools until late winter and spring of the following year before spawning. Mattole River summer steelhead can be large in size, averaging 26 inches and 24 inches, or more for males and females respectively. Egg deposition occurs in early spring with the young hatching about 50 days later. Young steelhead generally remain in the Mattole River for two years followed by another one to three years of ocean life before returning to complete their life cycle. Ninety percent of the returning adults are three and four year old fish.

Fish Passage Barriers

Culverts constructed of steel, aluminum, or plastic are the most common stream crossing devices found in rural road systems. Culverts often create temporary, partial or complete barriers for adult and/or juvenile salmonids during their freshwater migration activities (Table 7). Passage barriers that can be created by culverts include an excessive drop at the culvert outlet (too high of entry jump required); an excessive velocity within the culvert; a lack of depth within the culvert; an excessive velocity and/or turbulence at the culvert inlet; and a debris accumulation at and/or within the culvert. The cumulative effect of numerous culvert-related passage barriers in a river system can be significant to anadromous salmonid populations (Taylor, 2001). Inventories and fish passage evaluations of culverts within the Humboldt County and the coastal Mendocino County road systems were conducted between August 1998 and December 2000 by Ross Taylor and Associates, under contract with the Department of Fish and Game's Fishery Restoration Grants Program (Taylor, 2000, 2001). These inventories included 67 and 26 stream crossings in Humboldt and Mendocino Counties, respectively, of which 18 were in the Mattole Basin.

These culvert inventories and fish passage evaluations followed a standardized assessment procedure. First, all culverted stream crossings that may inhibit fish passage were located and counted. Second, each culvert location was visited during both late-summer/early fall low flow conditions and after early storm events. Third, information was collected regarding culvert specifications (Table 8.). Fourth, fish passage at each culvert was assessed using culvert specifications and passage criteria for juvenile and adult salmonids (from scientific literature and Fish Xing computer software) and on-site observations of fish movement. Last, the quality and quantity of stream habitat above and below each culvert was assessed. Habitat information was obtained from habitat typing surveys conducted by DFG, watershed groups and/or timber companies.

Following the culvert inventory and fish passage assessment, a prioritized list of culverts that that impede fish spawning and rearing activities was compiled for Humboldt and Mendocino counties. Criteria for priority ranking included salmonid species diversity, extent of barrier problem present, culvert risk of failure, current culvert condition, salmonid habitat quantity, salmonid habitat quality, and a total salmonid habitat score. The reports of the culvert inventories and fish passage surveys were provided to the Humboldt and Mendocino counties' Public Works, Natural Resources and Engineering Divisions, the DFG Native Anadromous Fish and Watershed Branch, and the DFG Region One Headquarters.

Culvert repair, upgrade, and improvement are an important part of stream restoration projects. In the Mattole Basin, the DFG North Coast Watershed Improvement Program includes culverts as a part of stream restoration and improvement efforts and was able to supply NCWAP with information on recent culvert assessment and treatment contracts. Typically, following assessments like those done by Ross Taylor and Associates, the County or landowner follows up with improvement proposals to DFG for funding support to implement recommendations. In the Mattole Basin, some of the recommended treatments are currently proposed or being implemented.

Table 7 Definition of Barrier Types and Their Potential Impacts (From Taylor, 2000, 2001).

Barrier Category	Definition	Potential Impact
Temporary	Impassable to all fish some of the time	Delay in movement beyond the barrier for some period of time
Partial	Impassable to some fish at all times	Exclusion of certain species and lifestages from portions of a watershed
Total	Impassable to all fish at all times	Exclusion of all species from portions of a watershed

Table 8 Specifications Collected at Each Surveyed Culvert (Taylor, 2000, 2001).

Specification	Description
Longitudinal Survey	Longitudinal survey was shot at each culvert to provide accurate elevation data
Fill Estimate	Amount of fill estimated by calculating the volume of the fill prism between the road surface and the culvert
Length	To nearest 1/10 ft
Dimensions	Diameter (circular), or height and width (box culverts), or span and rise (Pipe arches)
Type	Corrugated metal pipe, structural steel plate, concrete pipe, concrete box, bottomless pipe arch, squashed pipe-arch, or a composite of materials
Overall condition	Overall condition of the pipe
Rust line	Height and width of the rust line (if present)
Position	Position relative to flow and stream gradient
Jump Pool	Depth of jump pool below culvert
Jump Height	Height of jump required to enter culvert
Modifications	Previous modifications (if any) to improve fish passage
Modification Condition	Conditions of previous modifications

Fish History and Status

Fishery resources of the Mattole Basin include fall-run chinook salmon, coho salmon, summer-run steelhead trout, and winter-run steelhead trout. Other fish present include sticklebacks, lampreys, and sculpins (Table 9.). Two notable fish species that have apparently gone extinct in the Mattole Basin are spring-run chinook salmon (DFG 1972) and green sturgeon (Moyle et al. 1989). Many fish in the Mattole Basin use the estuary for spawning and juvenile rearing habitat.

Table 9: Fish Species in the Mattole River Basin.

Common Name:	Scientific Name:
chinook salmon	*Oncorhynchus tshawytscha*
coastrange sculpin	*Cottus aleuticus*
coho salmon	*Oncorhynchus kisutch*
pacific lamprey	*Lampetra tridentata*
pacific staghorn sculpin	*Leptocottus armatus*
prickly sculpin	*Cottus asper*
rainbow trout	*Oncorhynchus mykiss*
river lamprey	*Lampetra ayresi*
sacramento sucker	*Catostomus occidentalis*
shiner perch	*Cymatogaster aggregata*
starry flounder	*Platichthys stellatus*
surf smelt	*Hypomesus pretiosus*
threespine stickleback	*Gasterosteus aculeatus*
topsmelt	*Atherinops affinis*
western brook lamprey	*Lampetra richardsoni*

Though anecdotal evidence provides a convincing case that anadromous salmonid runs in the Mattole Basin were large and have experienced a sharp decline since the mid 1950s, little quantitative historic data exists (BLM, 1996). Estimates of chinook salmon, coho salmon, and steelhead trout populations in the Mattole Basin were made by the United States Fish and Wildlife Service (USFWS) in 1960. Existing populations of 2,000 chinook salmon, 5,000 coho salmon and 12,000 steelhead trout were estimated, while potential populations of 7,900 chinook salmon, 10,000 coho salmon and 10,000 steelhead trout were predicted (Figure X.). In 1965, the Department of Water Resources (DWR) reported that chinook salmon were able to access the Mattole River for 45 miles, while coho salmon and steelhead trout used several more miles of the river (see maps on following pages). Chinook salmon spawned mostly on the mainstem, though several tributaries such as the North Fork of the Mattole River, Honeydew Creek, and Bear Creek also provided suitable spawning areas. Coho salmon and steelhead trout spawned mostly in smaller tributaries throughout the basin.

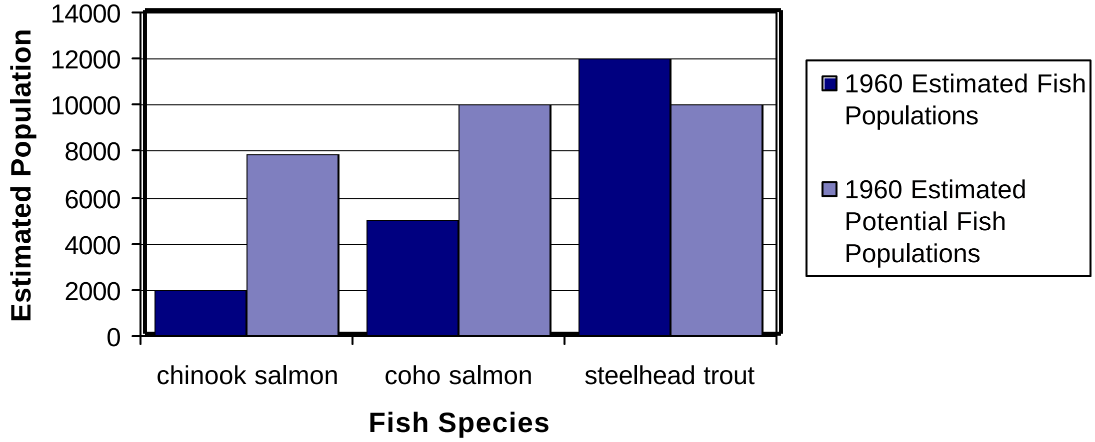

Figure X. 1960 USFWS estimates of fish populations and potential fish populations in the Mattole Basin.

DWR (1965) also speculated that increases in siltation and debris jams following intensive logging that started in 1952 had caused a significant reduction in the size of anadromous fish runs since 1955. Prior to 1954, the Mattole River had an exceptionally good winter steelhead trout fishery. The fishery had deteriorated seriously since then. In fact, DWR stated that:

> It is insufficient to note here that the Mattole River was formerly one of the better king salmon (chinook salmon), steelhead (trout), and silver salmon (coho salmon) producers of the entire coast. Since 1950, excessive logging operations have taken place in the drainage, which has severely damaged the stream, primarily from siltation. The stream is still considered to have the potential to again be the major fish producer that it was historically if improved logging and land management principles are followed.

Most of the chinook salmon catch after 1954 was made during November, although an occasional fish was taken in the estuary as early as October. Steelhead trout and an occasional coho salmon were taken whenever water conditions were favorable. USFWS surveys during 1956-1957 and 1957-1958 seasons indicated that an average of 4300 angler days were spent on the river, resulting in a catch of 400 salmon, 700 steelhead trout, and about 8000 juvenile steelhead trout. A need for better stream survey data was recognized in 1965, when DFG recommended that thorough surveys of existing conditions be carried out so as "to permit management of the resource by knowledge, not guesswork."

DFG conducted 65 stream surveys on 58 Mattole River tributaries in the mid 1960s. Survey reports included drainage, stream condition, habitat suitability, stream obstruction, and fisheries descriptions. Salmonid presence and habitat characteristics were usually determined by direct observation. Survey reports concluded with recommendations for management. DFG continued to survey streams in the Mattole Basin in the 1970s and 1980s with an emphasis on locating possible salmonid passage barriers. With the publication of the first edition of the *California Salmonid Stream Habitat Restoration Manual* in 1991, stream survey methodologies used by DFG became standardized and more quantitative. Fifty tributary reports were completed for the Mattole Basin in the 1990s.

The BLM also conducted 40 stream surveys in the Mattole Basin starting in the 1970s. BLM survey reports included access, drainage, stream conditions, habitat suitability, and fisheries descriptions. Salmonid presence and habitat characteristics were usually determined by direct observation. Survey reports concluded with recommendations for management.

C.J. Brown (1972, 1973a, 1973b) conducted a study of the downstream migrations of salmonids, a creel census and fisherman-use count, and an estimate of salmonid standing stocks for the Mattole River. Downstream migrant salmonids were trapped in the spring of 1972 to gain some insight into their distribution within the Mattole River and the timing of their emigrations (Brown 1972). Nets were set on the Mattole River 1.5 miles above the Petrolia bridge, and 100 yards below the mouth of Bear Creek in between April and June. Results indicated that chinook salmon emigration in the Mattole River ceased by May, coho salmon emigrants were present from April through June, and steelhead trout exhibited some downstream movement in May and June. Brown (1972) also speculated that the Mattole estuary may be an important rearing area for chinook salmon and steelhead trout.

A census of angler use and catch was made in February 1972 and from September 1972 through February 1973 on the Mattole River downstream from Honeydew to determine the general nature of the fisheries and the number of fishable days occurring during a typical year (Brown 1973a). There were two distinct groups of anglers in the Mattole River: salmon anglers and steelhead anglers. Salmon anglers were characterized as local residents who fished from boats in the estuary from late September until winter storms allowed salmon to move upstream in early November. Fourteen anglers sampled in October 1972 had a catch per angler hour of 0.124. Steelhead anglers were characterized as excellent fishermen who traveled long distances, put in long days fishing, and were frequently successful. An average angler-day was 7.1 hours, the average catch per angler day was 0.45, and the average catch per angler hour was 0.064 in February 1972. The Mattole River was fishable for only 9 ½ days during February of 1972, though every day from May through August 1972 was fishable. Most of September and October were fishable, but turbid water limited fishing to only a few days per month by November 1972. Turbidity prevailed throughout most of the steelhead fishing season (November 21, 1972 through February 28, 1973), though at least 28 days were fishable. The river had been fishable for 24 days during the 1971-72 steelhead fishing season.

Estimates of the abundance and distribution of juvenile salmonids in the Mattole Basin were made in 1972 to determine the effect of a proposed dam on salmonid resources (Brown 1973b). The proposed dam was at Nooning Creek. Standing stocks of salmonids were estimated at 24 stations (18 stations above the proposed dam and six below the proposed dam) in the Mattole Basin using electro-fishing surveys (Table 10.). Salmonid populations at nine stations on the mainstem Mattole River ranged from 30 to 201salmonids per 100 feet. Young-of-the-year steelhead trout predominated at these stations. Coho salmon fry were found at only one station (1.0 miles upstream from Baker Creek). Salmonid populations at 15 stations on tributaries to the Mattole River ranged from 14 to 608 salmonids per 100 feet. Young-of-the-year steelhead trout predominated at all tributary stations. Coho salmon were found at four stations on tributaries (Harris Creek, Baker Creek, Thompson Creek, and Mattole Canyon Creek). Sampling effort was not sufficient to accurately estimate the numbers of salmonids in the mainstem Mattole River above the proposed Nooning Creek dam site. Nevertheless, Brown (1973b) very roughly estimated that the proposed dam would eliminate nursery areas for 125,283 steelhead trout and 1,713 coho salmon.

***Table 10: Estimates of Salmonid Populations in 1973*. From 100 foot sampling stations on the Mattole River and tributaries (after Brown 1973b)**

Location	100 foot section population estimate (95% confidence interval)	Species composition		
		Steelhead trout		Coho salmon
		Young-of-the-year	Yearling & older	
Mattole River 100 yards downstream from Bridge Creek	151 (138-164)	*	*	0
Mattole River 10 yards upstream from Baker Creek	45 (43-47)	98	2	0
Mattole River 0.5 miles upstream from Baker Creek	98 (79-117)	84	16	0
Mattole River 1.0 miles upstream from Baker Creek	33 (31-35)	81	13	6
Mattole River 0.5 miles upstream from Thompson Creek	127 (113-141)	92	8	0
Mattole River 1.5 miles upstream from Thompson Creek	30 (21-39)	85	15	0
Mattole River 2.0 miles upstream from Thompson Creek	35 (31-39)	82	18	0
Mattole River under Ettersburg Bridge	67 (58-76)	93	7	0
Mattole River 0.5 miles above Bear Creek	201 (125-277)	100	0	0
McKee Creek (near mouth)	209 (201-217)	99	1	0
McKee Creek (1.0 mile above mouth)	67 (59-75)	60	40	0
Vanauken Creek (near mouth)	112 (99-125)	99	1	0
Vanauken Creek (1.0 mile above mouth)	37 (34-40)	100	0	0
Mill Creek (near mouth)	14 (10-18)	100	0	0
Mill Creek (1.0 mile above mouth)	62 (55-69)	100	0	0
Harris Creek (near mouth)	48 (40-56)	98	0	2
Baker Creek (near mouth)	58 (48 – 68)	79	0	21
BakerCreek (1.0 mile above mouth)	50 (47-53)	80	3	17
Thompson Creek (near mouth)	71 (61-81)	95	5	0
Thompson Creek (1.0 mile above mouth)	62 (50-74)	81	2	17
Mattole Canyon Creek (near mouth)	608 (406-810)	98	1	1
Squaw Creek (near mouth)	74 (57-91)	100	0	0
North Fork of the Mattole River (0.5 miles downstream from Petrolia Road Bridge)	122 (102-142)	87	13	0
North Fork of the Mattole River (1.5 miles above the mouth)	250 (208-292)	95	5	0

* Juvenile steelhead not separated by age at this station.

The Coastal Headwaters Association surveyed just over 200 perennial stream miles in the Mattole Basin in the early 1980s under contract with DFG. They conducted five different types of stream surveys: pre-inventory surveys, ocular surveys, detailed habitat surveys, spot-checks, and high-water surveys. Pre-inventory surveys consisted of obtaining land-owner permission to access streams, and obtaining and reviewing all available maps for an area, previous stream surveys, and historical information. Ocular surveys provided a basic description of fish populations, habitat conditions, and rehabilitation needs but usually did not involve the collection of quantitative data. Detailed habitat surveys were similar to ocular surveys, but included actual measurements of habitat features such as pools, runs, and riffles. Spot-checks consisted of fish and habitat observations at point locations in easily accessible areas like bridges. Spot-checks often included the use of minnow-traps to sample juvenile salmonids. Lastly, high-water surveys were used to estimate spawning salmonid populations and followed procedures used by the DFG Anadromous Fisheries Branch (1981). Findings of the Coastal Headwaters Association's stream surveys were summarized in the First Annual Report of the Mattole Survey Program in 1982.

More details of tributary conditions described in DFG, BLM, Coastal Headwaters Association and other Reports are given in the analyses and results by subbasin section of this report.

Additional sources of information about anadromous salmonids in the Mattole Basin include stocking records, watershed analyses, and other studies of tributaries and salmonids. The Mattole Basin was stocked with steelhead trout, coho salmon and/or chinook salmon from 1930 to 1981 (Table 11). The vast majority of fish released were steelhead. Detailed Watershed Analyses have been carried out by the BLM for Bear Creek (1995), Honeydew Creek (1996), and Mill Creek (lower) (2001), and Hamilton (1982) surveyed Nooning Creek as part of a research proposal. Additionally, Nehlsen et al. (1991) and Higgins et al. (1992) both mention Mattole salmonid runs in their overviews of the risk of extinction of salmon runs in the Pacific and Northern California, respectively. They concluded that fall-run chinook salmon and coho salmon in the Mattole Basin had a high risk of extinction.

Table 11: Stocking Records for the Mattole Basin from 1930 to 1981.

Date	Species	Number	Where Released
1930	Steelhead	50,000	
1931	Steelhead	50,000	Upper Mattole River
1932	Steelhead	105,000	
1933	Steelhead	40,000	Upper Mattole River
1933	Steelhead	30,000	At Thorn and Ettersburg
1934	Steelhead	20,000	At Thorn and Ettersburg
1934	Steelhead	10,000	North Fork Mattole River
1934	Steelhead	10,000	
1935	Steelhead	60,000	Upper Mattole River
1935	Steelhead	36,000	North Fork Mattole River
1935	Steelhead	36,000	
1936	Steelhead	25,000	Upper Mattole River
1936	Steelhead	20,000	North Fork Mattole River
1936	Steelhead	20,000	
8/22 – 23/1938	Steelhead	2,690	Upper Mattole River
8/23/1938	Coho salmon	1,000	
8/22-24/1938	Chinook salmon	4,940	Upper Mattole River
6/20/1961	Steelhead	~59,000	Ettersburg
6/21/1961	Steelhead	~42,000	Ettersburg
6/21/1961	Steelhead	~86,000	Honeydew
5/9/1972	Steelhead	10,220	Bear Creek
5/10/1972	Steelhead	9,520	2 miles north of Whitethorn
5/12/1972	Steelhead	10,325	2 miles north of Shelter Cove
4/25/1973	Steelhead	19,067	2 miles north of Whitethorn
5/19/1975	Steelhead	30,012	2 miles north of Whitethorn
3/3-5/1981	Steelhead	100,000	Above or below Honeydew

The Mattole Salmon Group (MSG) was formed in 1980 as a response to local citizen's concerns about declining salmonid populations. MSG represents a watershed-wide, entirely citizen-run effort to begin restoring native salmon runs. MSG promotes and operates a broad-based program aimed at restoring the native salmonid fishery in the Mattole Basin. Two important focus areas of the MSG program are monitoring fish populations, and maintaining and enhancing the remnant runs of native fall-run chinook salmon and coho salmon (MSG 2000).

MSG monitors fish population in the Mattole Basin through spawning surveys and downstream migrant trapping. As a part of their activities, MSG has conducted annual spawning surveys since the 1981-1982 season to provide estimates of salmon escapement in specific index reaches and for extrapolation to basin-wide population levels. Estimated basin-wide populations of chinook salmon and coho salmon for the 1999-2000 season were 700 and 300, respectively (Figure X.).

Chinook salmon and coho salmon spawner estimates.

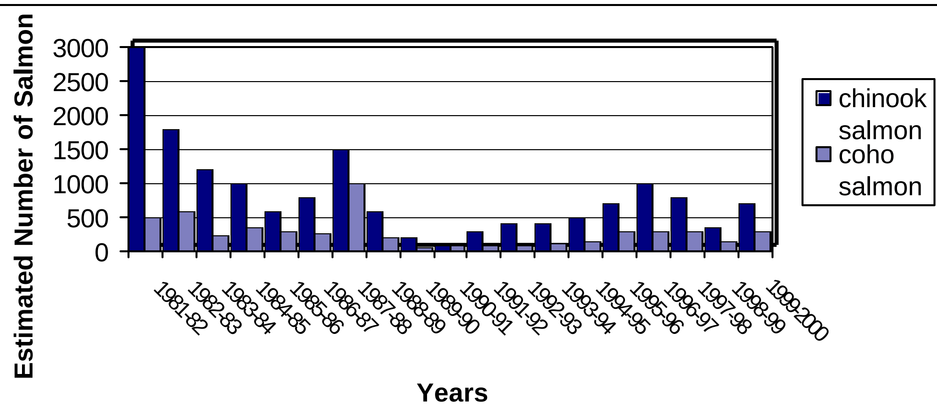

Figure X. Mattole Salmon Group estimates of returning adult chinook and coho salmon spawners to the Mattole Basin from 1981-2000. Data is based on annual synthesis of spawning surveys and counts at a temporary fish weir in the Mattole River near the confluence with Mill Creek. Data provided by the Mattole Salmon Group.

MSG has conducted downstream migrant trapping in the lower mainstem Mattole near Mill Creek, at river mile (RM) 2.9, in the spring and early summer to monitor the timing of down-migration and to document the size of emigrating salmonid juveniles since 1985. The number of fish caught cannot be construed as a fish population estimate because of unknown trap efficiency and avoidance of the trap by fish at high flows. Data from 1995-2001 indicates that the majority of salmonids trapped are steelhead trout, followed by chinook salmon and coho salmon (Figures Xa. and Xb.) MSG started another downstream migrant trap on Bear Creek 300 ft upstream from its confluence with the Mattole River in 1997. The confluence of Bear Creek and the Mattole River is at RM 42.8. Data from the trap on Bear Creek also show that more steelhead trout are caught than chinook salmon and coho salmon (Figure Xc. and Xd.). A third fish trap was placed on the mainstem Mattole River at Ettersburg in 2001 (RM 42.9). This trap caught 1,923 chinook salmon, 6 coho salmon, 4,863 young-of-the-year steelhead trout, 541 steelhead trout 1+, and 33 steelhead trout smolts.

Downstream Migrant Trapping, 1995-2001

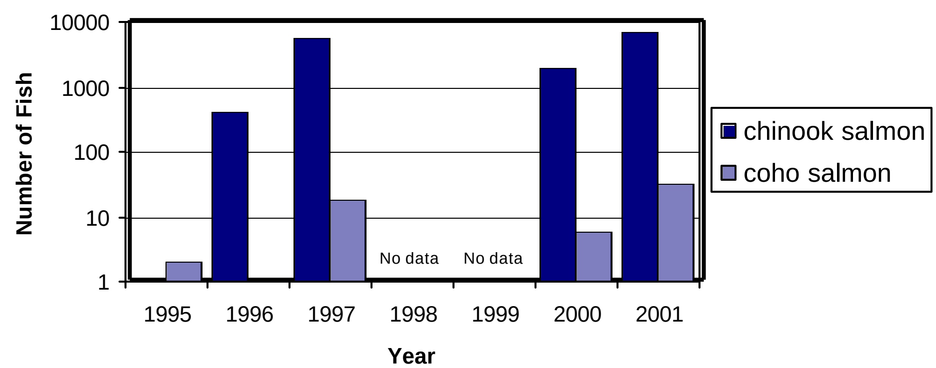

Figure Xa. Outmigrant chinook and coho salmon trapped by the Mattole Salmon Group in the spring and early summer in the Mattole River near Mill Creek (RM 2.9) from 1995-2001. Data provided by the Mattole Salmon Group.

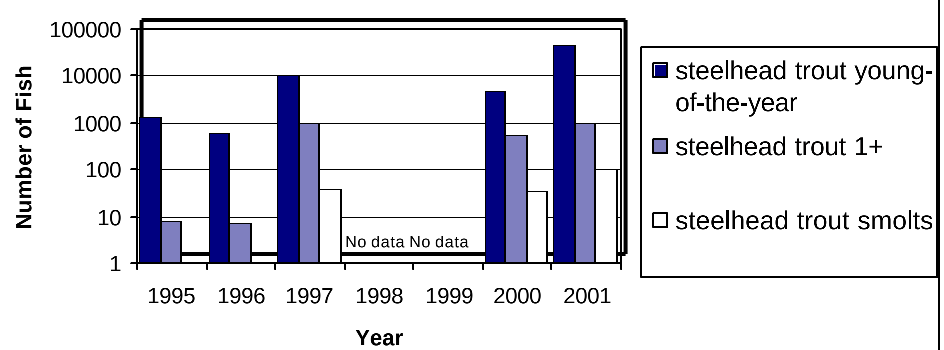

Figure Xb. Outmigrant steelhead trout trapped by the Mattole Salmon Group in the spring and early summer in the Mattole River near Mill Creek (RM 2.9) from 1995-2001. Steelhead were separated into young-of-the-year, 1+, and smolts. Data provided by the Mattole Salmon Group.

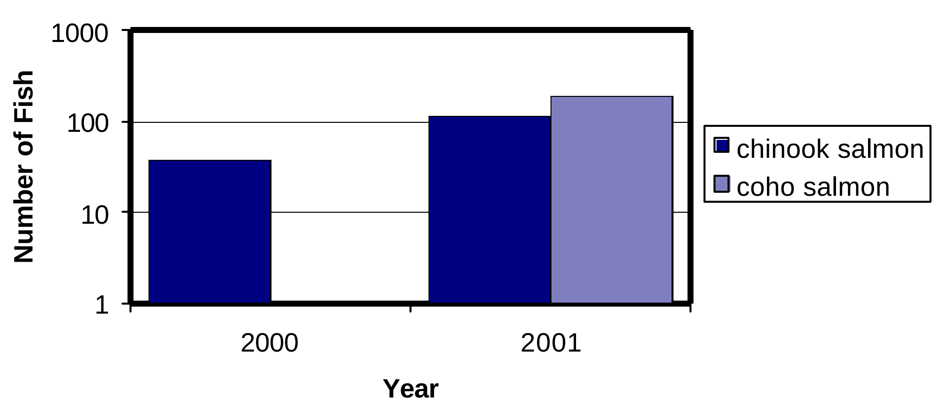

Figure Xc. Outmigrant chinook and coho salmon trapped by the Mattole Salmon Group in the spring and early summer in Bear Creek 300 ft from its confluence with the Mattole River from 2000-2001. Data provided by the Mattole Salmon Group.

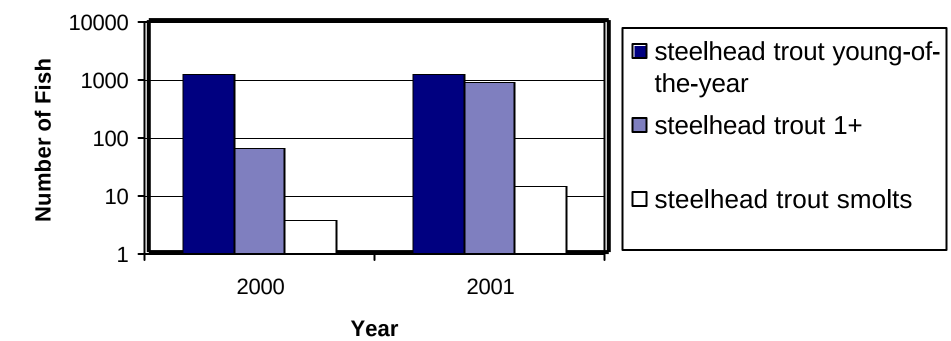

Figure Xd. Outmigrant steelhead trout trapped by the Mattole Salmon Group in the spring and early summer in Bear Creek 300 ft from its confluence with the Mattole River from 2000-2001. Steelhead were separated into young-of-the-year, 1+, and smolts. Data provided by the Mattole Salmon Group.

MSG maintains and enhances the remnant runs of native fall-run chinook salmon and coho salmon in the Mattole Basin through a hatchbox program and a rescue-rearing program. The goal of these programs is to restore native salmon runs to self-sustaining levels that can be maintained without artificial propagation or other significant human intervention. MSG is part of the DFG Cooperative Trapping and Rearing Program. Beginning in 1981, MSG has trapped wild adult chinook and coho salmon in the Mattole Basin for use as broodstock. Eggs are obtained from females and fertilized. Fertilized eggs are incubated in hatchboxes. After hatching, fry are reared for 6 weeks before release.

All artificially propagated fish are marked, in order to provide estimates of hatchery-to-wild ratios. Adult trapping data from 1995 to 1999 suggest an overall hatchery-to-wild ratio of 13:131, and spawning ground surveys over the same time period suggest a hatchery-to-wild ration of 3:98.

For the past several years in May and June, MSG has also trapped chinook out-migrants just upstream of the estuary. Extensive studies from 1985-92, led by Humboldt State University, found that chinook juveniles were suffering lethal impacts during summer rearing in the estuary. Therefore, MSG project personnel and volunteers net up to 6,000 naturally spawned downstream migrant salmonids each year and hold them in rearing ponds at Mill Creek. Volunteers rear fish until water temperatures drop and/or the lagoon opens to the sea with fall rains. The combined number of chinook salmon released from the MSG's hatchbox rearing program and their rescue-rearing program since 1981 is over 500,000.

Fishing Interests, Constituents

Historically, during the winter months sport fishing for salmon and steelhead has drawn anglers from throughout California and other states to the Mattole River, which has been an important contributer to both sport and commercial marine fisheries. Due to declining populations, chinook and coho salmon, and steelhead are currently listed as threatened under the federal Endangered Species Act. The "threatened" status now restricts river sport fishing on Mattole stocks. The winter salmon and steelhead fishery of the Mattole River is managed as a catch and release fishery from January 1 to March 31. Only barbless artificial lures may be used. Additionally, the Mattole River main stem from confluence with Stansberry Creek to confluence with Honeydew Creek is open from the fourth Saturday in May through August 31, for catch and release fishing with barbless artificial lures.

Fish Restrictions, Acts, Protections

Fish Restoration Programs

Beginning in 1981, the Mattole Salmon Support Group has trapped and raised Chinook and coho salmon. In the upper reaches of the river system, the group has used hatch boxes placed instream to incubate fertilized eggs taken form locally trapped chinook and coho broodstock. Presently, the Mattole Salmon Support Group is part of the DFG Cooperative Trapping and Rearing Program. For the past several years in May and June, the group has also trapped chinook out-migrants just upstream of the estuary / lagoon. Due to a combination of watershed factors, the estuary outlet closes in June or July in most years preventing smolts from escaping very warm to lethal freshwater temperatures into the relative safety of the ocean. Project personnel and volunteers net up to 6,000 naturally spawned downstream migrants each year and then hold them in rearing ponds at Mill Creek (River Mile 2). The fish are reared by the volunteers until released to the estuary when river stream temperatures drop and/or the lagoon opens to the sea with fall rains. In the fourteen years of the program between 1981 and 1995, more than 500,000 king salmon have been released between the upstream and estuarine operations.

Special Status Species

Due to declining populations in the Mattole River, chinook salmon, coho salmon and steelhead are listed as "Threatened" under the Endangered Species Act. Other special status species of the Mattole River basin are presented in Tables 10 (California Rivers Assessment Interactive Web Database 2001).

Table 12: Special Status Species of the Mattole River Basin.

Name	Scientific Name	Federal Listing	State Listing
beach layia	*Layia carnosa*	Federally listed as Endangered	California-listed as Endangered
leafy reed grass	*Calamagrostis foliosa*	None-No Federal Status	California-listed as Rare
coho salmon	*Oncorhynchus kisutch*	Federally listed as Threatened	California-candidate species for listing
foothill yellow-legged frog	*Rana boylii*	Federal Species of Concern	None-No State classification
northern spotted owl	*Strix occidentalis caurina*	Federally listed as Threatened	None-No State classification
tailed frog	*Ascaphus truei*	Federal Species of Concern	None-No State classification

Mattole Assessment Process Summary

General

Our initial public meeting in the Mattole was held in April, 2001, where we presented our program and solicited public participation to identify issues and interested participants from the watershed. As a result, the DFG recruited and hired one contract field technician, and a Scientific Aide from within the watershed community. These folks conducted data research and limited data collection. They have also assembled a good portion of the Bibliography for the DFG. Later, we were able to hire, on a consultancy basis, a 22-year veteran Mattole River fishery biologist to submit historical information about the fisheries, and analyze with our staff, two decades of fishery information. We had another public meeting on Oct. 17. At that time, the nine person NCWAP team presented our current product status and discussed issues with 25 interest group participants. As a result, specific DMG staff were invited to conduct verification field work on four major non-industrial properties. Outreach meetings were also held with Pacific Lumber Co. Peer review has involved meeting with scientists from Redwood Sciences Lab, BLM, and EPA.

Issues and Hypotheses

After conducting public scoping meetings and initial analyses of available data, the NCWAP team compiled a list of issues affecting the Mattole Basin. Based upon these issues, the team then developed a set of hypotheses to give direction to their scientific inquiry. A hypothesis is a tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation. The issues affecting the Mattole Basin and hypotheses raised by these issues follow.

Mattole Issues:

- Sediment, temperature, pool habitat, escape and ambush cover, and substrate embeddedness in the estuary are thought to be outside of supportive levels for salmonids in the estuary.
- Predation upon depressed fish populations by birds and mammals is thought to be a problem in the estuary.
- Abandoned roads, new road construction, and road maintenance issues related to landsliding and sediment input to streams are concerns in much of the basin.
- Sub-division development and construction are concerns in some parts of the basin.
- High water temperatures are a concern in some parts of the basin.
- High sediment is a concern in some parts of the basin.
- Low stream shade canopy cover is a concern in some parts of the basin.
- Absence of salmonid information, low fish densities, or absences of fish are concerns in some parts of the basin.
- Large woody debris recruitment to streams is a concern in some parts of basin.
- Low stream habitat diversity and complexity is a concern in some parts of the basin.
- Diesel spills into tributaries like Blue Slide Creek are concerns.
- Access to areas for field studies is a concern in some parts of the basin.
- Herbicides used on industrial timberlands are a concern in some parts of the basin.
- Excessive extraction of water during low flow periods is a concern in some parts of the basin.
- Location and conduct of timber harvest operations are a concern in some parts of the basin.

Working Hypotheses:

- Variability in the geology, climate, vegetation and land use in the Mattole Basin is too high for a single general analysis and assessment to be representative of the entire basin.
- The establishment of an analytical framework comprised of large subbasins with common attributes and characteristics will provide a more satisfactory assessment scale.
- The current abundance and distribution of salmonid populations observed in the basin are indicators of the current habitat conditions.
- Summer stream temperatures in the basin are not within the range of temperatures that fully support healthy anadromous salmonid populations.
- Aggradation from fine sediment in some stream channels has reduced channel diversity needed to fully support anadromous salmonid populations and has compromised salmonid health.
- High natural rates of sediment input to streams are augmented by human land use activities in some parts of the basin.
- Some stretches of streams in the basin are not fully supportive of salmonids due to stream flow reductions related to human diversion.
- A lack of large woody debris in some stream reaches has reduced channel diversity needed to fully support anadromous salmonid populations and has compromised salmonid health.
- Air photo documentation after the 1955 and 1964 floods indicate significant changes instream channel and riparian conditions as a result of those events.
- Watershed and stream conditions in the Southern subbasin are the most supportive of salmonids in the Mattole Basin.
- Watershed and stream conditions in the Eastern and Western subbasins vary between being supportive and non-supportive of salmonids.
- Watershed and stream conditions in the Northern subbasin are the least supportive of salmonids in the Mattole Basin.
- The present state of estuarine habitat is limiting the production of salmonids, especially chinook, in the Mattole Basin.

Assessment Activities

During scoping, this watershed was found to have had most tributaries recently surveyed with the standard DFG channel, stream and biological sampling methodologies contained within the DFG restoration manual. About 96 miles of streams had been surveyed with reports created about each tributary. However, a need was identified to research and organize a variety of existing and historical information, which had been developed and were held by regional agency personnel, watershed landowners and constituent groups.

Basin Synthesis Report

The Mattole was sub-divided into five planning subbasins for assessment and organization within the report. Each subbasin has somewhat unique attributes which are common among the several Department of Forestry (CDF) Calwater 2.2a planning watersheds contained within them. Calwater units are approximately 5,000-10,000 acres and are used as planning and evaluation units for projects such as Timber Harvesting Plans submitted to CDF. They are used as the basis of our Geographical Information System (GIS) upon which various coverages are overlain. They are also used as the basis of our Ecological Management Decision Support System GIS portrayals and analyses (see below). In this report issues present in each of the various planning subbasins are discussed from the various points-of-view among the multi-disciplinary team (e.g. Issues: Development of subdivision roads; water extraction; elevated water temperatures, extent of timber harvest, etc.). The report will be "in progress" by our personnel until the May 1 final draft submittal due date. If successful, it will be a "living" document that future analysts can use as a "base-line" record and record change over time in the watershed by interested constituents.

EMDS in the Mattole River Basin Assessment

Both stream reach and watershed level Ecological Management Decision Support model runs were conducted on the Mattole assessment. The model outputs are used in the synthesis reports. The results, in general, indicate the headwaters (Southern, Eastern, and Western subbasins) areas of the system are in relatively good condition. The Northern and Estuarine subbasins are in relatively poor condition for supporting salmonid populations. This output is in agreement with the NCWAP hypotheses.

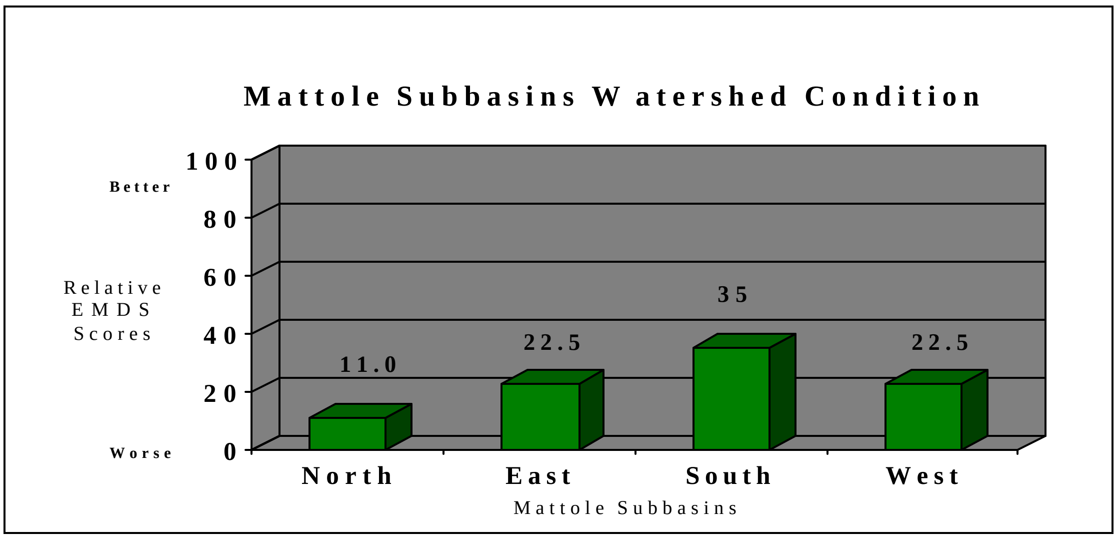

Figure 9: EMDS Evaluation Scores for the Mattole Subbasins.

The Ecological Management Decision Support (EMDS) system watershed model was run at the subbasin scale to compare their overall watershed conditions. The parameters used and operation of the EMDS model are fully discussed in the EMDS Appendix. In general, the model calculates values determined by analysts on the condition of the attributes of roads, stream reaches, fish passage barriers, and upland components.

The result is an overall raw score ranging from +1, which represents full agreement that a parameter's condition is supportive of salmon and steelhead, to –1, which is full agreement that a parameter's condition is not supportive of salmon and steelhead. The logical network system of the EMDS combines the values and ultimately generates a single score for the watershed's ability to support salmon and steelhead. The model is completely transparent and allows planners and managers to explore the model's parameter network to determine which factors are responsible for the watershed score. Figure 9 shows a general EMDS evaluation for each subbasin upstream from the estuary of the Mattole Basin.

The Mattole subbasins' EMDS watershed evaluations are arrayed on a scale from zero, fully un-supportive of salmon and steelhead, to one hundred, fully supportive of salmon and steelhead. The model's detailed results are presented in EMDS Appendix.